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then there is the Weather Bureau, which is making a daily map of the heavens to exhibit the temperature and storms of the land in the interest of commerce and agriculture; then there is a Hydrographic Bureau preparing charts of all the seas in the interests of foreign commerce. In addition to these great geographical bureaus there are many others that are necessarily interested in geography. Thus, the General Post Office must prepare maps of postal routes. Now the little army of men who are engaged in geographical work in Washington organized themselves into a body known as the National Geographic Society. When they were duly organized they cast about for some one who could manage their affairs as its president and who would interest himself in the diffusion broadcast among the people of this geographical knowledge, which all these bureaus were acquiring. The man selected for this purpose was Gardiner Greene Hubbard, who was elected its first president.

The function of the National Geographic Society is the discussion of the principles of geography and the diffusion of geographical knowledge among the people. To carry out this purpose Mr. Hubbard organized a journal called the *National Geographic Magazine*, which has already acquired a good circulation and become an influential publication. Then he organized a system of bulletins designed to discuss the elements of physiography as a compendious library for teachers in the public schools, and finally he organized in the city of Washington a system of public lectures on geography, enlisting not only the members of the Society, but many other able public men in this enterprise. In all of these agencies the working geographers of Washington most heartily cooperated, and the National Geographic Society has within very few years attained an influence and efficiency which is unequalled in America

and perhaps in the world. Thus Mr. Hubbard was the *entrepreneur* of geographical knowledge.

Investigation and discovery lead to useful, honorable and glorious careers, but knowledge must result in invention if it becomes useful, and inventions themselves must be applied to public affairs if they are to be a boon to mankind.

Mr. Hubbard died at three o'clock on the 11th of this month, loved by his kindred, beloved by his friends and honored by the world.

ON THE ORIGIN AND AGE OF THE RELIC-BEARING SAND AT TRENTON, N. J.*

THE locality where human antiquities have recently been found near Trenton, New Jersey, is situated about two miles south of the heart of the city. The points where the finds are being made are on a somewhat extensive plain, the principal formation of which is composed of the sand and gravel deposited by the glacial drainage which came down the Delaware during the last glacial epoch. On the east side of the Delaware the plain extends about two miles east of the locality where the finds are made. It also has a considerable development on the west side of the river, and extends many miles up and down the Delaware north and south of the locality in question. From Trenton it also stretches northeast a number of miles along the Assanpink creek. In the vicinity of Trenton this plain has an elevation of 50 to 60 feet. Through it the Delaware has cut a wide valley, the flood-plain of which is now less than ten feet above sea-level. The relation of the flood-plain to the plain above shows that, after the latter was made, the river excavated a valley in it, cutting it down essentially to tide-level. This valley has been cut since the last glacial epoch.

* Paper presented at the summer meeting of the American Association for the Advancement of Science.

The gravel plain to the east and north of the point where the finds are made ends abruptly at the margin of the post-glacial valley, in a bluff about forty feet in height, with a slope which is about as steep as the material of which it is composed will lie.

The relations shown on the New Jersey side of the river are in a general way duplicated on the Pennsylvania side. The gravel of glacial age has a similar disposition, but the border of the valley on that side is not so sharply defined, indicating that the more recent cutting of the stream has been on the east. The steepness of the bluff of gravel at the points concerned is in itself proof of the recency of the excavation on this side.

The surface of the plain is slightly undulatory, though the relief is usually but a few feet. In places erosion has affected it to some slight extent, and in places its surface appears to have been left slightly uneven by the deposition of the material of which it is made. Its surface is also characterized at various points by low mounds and ridges of sand heaped up by the wind. By this means an element of undulatoriness has been added to the surface as originally left by the deposition of the main body of sand and gravel involved.

While the plain consists of sand and gravel, so far as its general constitution is concerned, its surface is in many places coated with a thin layer of sandy loam, which contains occasional pebbles similar to those which make up the body of the gravel beneath. It is not always possible to say to what extent the surface loam represents the last stage of deposition of the glacial sands and gravel; to what extent it represents the surface accumulation of loamy matter brought up from lower levels by the action of biotic agencies, such as worms, ants, burrowing mammals, etc.; or to what extent it represents deposition by marine or estuarine waters which stood

over the region after the glacial drainage ceased to flow through this part of the Delaware.

Relations similar to those where the human relics just south of Trenton are found characterize the east side of the Delaware for many miles further south. In this direction materials derived from glacial waters are less readily identified at most points, but the topography and relations of the plain bordering the Delaware are such as to show that it was developed contemporaneously with the plain at Trenton. Even where not made up chiefly of glacial materials, the plain further south, like that at Trenton, is slightly undulatory, and is coated, in places, with dune sand. Such sand is especially likely to be found on the west edge of that part of the plain which lies east of the Delaware, and just east of the line where the plain descends with a bluff face to the flood-plain of the stream. Well-marked dunes sometimes appear in this situation, and dune sand in larger or smaller quantity is so general that its presence along the edge of the plain above the valley may be said to be the rule, rather than the exception, between Trenton and Camden.

The same is true of the tributaries which come down to the Delaware from the east. Although they did not bring down glacial sands and gravels, they brought down sands and gravels of other sorts, partially filling their valleys, which, like the Delaware, have been re-excavated since. On the bluffs of the tributary valleys, as well as along the main stream, dune sand is of frequent occurrence. In the dune sand along these tributaries, relics of early peoples, consisting of chips of argillite, arrow-heads, and half-fashioned tools of various sorts, are frequently found.

Sand is found in similar relations at some points on the Delaware above Trenton. At many points it has been blown up from the

glacial gravel terraces to higher levels, though it rarely takes the forms of distinct dunes. It is frequently three to five feet in depth, facing the bluffs above the glacial plain in irregular patches, or capping their crests.

The trenches in which the human relics near Trenton have recently been found are upon the immediate edge of the plain overlooking the post-glacial valley of the Delaware. Here, as is frequently the case in such situations, the sandy loam over the gravel of glacial age is thicker than farther back from the bluff, but even here it is but three or four feet in thickness, including the black soil. It is in this sand and loam, quite above the materials which are clearly of glacial age, that the human relics are found.

In detail the sections shown in the trenches open in May and July showed a sandy soil affected by organic matter to the depth of six to twelve inches, the lower limit being ill-defined. The soil graded down into sand which was essentially free from organic matter, and which had a thickness of two to three feet. The sand was without apparent stratification. Below it lay the stratified drift, confidently referred to the time of the last ice epoch. It will be seen, therefore, that the relics were found in the structureless sand and loam which overlay the sand and gravel of glacial age.

Besides being essentially structureless, the sand and loam in which the relics were found contained occasional pebbles. Some of them were as large as one's fist, and occasionally one was found of still greater size, though most of them were tiny pebbles. Many of them were so small as to be within the power of wind to transport, while others were so large as to make this mode of transportation impossible.

In the sand there were at some points streaks more highly colored than the por-

tions above or below. These streaks had a position approaching horizontality, but in detail they were exceedingly irregular. Locally they were interrupted, apparently broken; and in other places they faded out altogether. In general they were thin, a trifling fraction of an inch in thickness. They were sometimes so faint as to be traceable with difficulty, while in other places they thickened to a quarter of an inch or more. While these streaks were often distinct, they were not to be mistaken for lines of stratification, with which they clearly had nothing to do. They could not be assumed to be the edges of stratification plains distorted by unequal sinking, for if this were their origin successive streaks in the same vertical section should have corresponded in their irregularities. This was not the fact, for one streak was liable to bend up just where the one a few inches below it bent down, a relation which excluded the idea of unequal settling. Furthermore, they were so irregular that their total length, as seen in the face of a trench, measuring all irregularities, was considerably greater than the length of the section itself.

These reddish streaks, which were thought to carry more pebbles than the other portions of the sand, seemed to be due to one or more of two or three causes. In places they seemed to be due to the concentration of coloring matter, especially iron oxide. In other places they looked rather as if fine reddish silt had accumulated along them through the influence of percolating water. In either case there must have been something in the texture along this irregular surface to occasion the concentration. The surface of which these irregular lines were the outcrops may perhaps once have been the upper surface of the land, subsequently buried by wind-blown dust and sand. Many of the little irregularities of the streaks were such as might be thus explained, though

the abrupt breaks in them must be accounted for in some other way. So far as I could make out, there was nothing except these reddish streaks which could by any possibility be mistaken for structure, and had I not known at the time of my second visit that they had been taken by others for stratification plains, I should not have supposed this interpretation a possible one.

Concerning the age and origin of the sand which contains the relics, no positive affirmation can be made, and it is only fair to say that this statement is made on the basis of a somewhat full knowledge of the surrounding region. So far as its stratigraphic relations are concerned, the relic-bearing sand might represent the last phase of deposition by glacial waters, or it might belong to any later epoch. Its absence of structure does not show that it was not deposited by water, for in the nature of the case it could not now be expected to show structure, whatever its origin. This would be true whether it represents (1) the last phase of deposition by glacial waters, (2) an estuarine deposit of later age, or (3) eolian sand; for the continually renewed perforation of the sand to the depth of several feet by the roots of plants, the continual borings of burrowing mammals, worms and insects, all of which frequently go down to the bottom of the sand overlying the gravel of glacial age, would quite certainly have destroyed all traces of stratification which the sand may once have had. If this were not enough, the freezing and thawing, and the wetting and drying, would have completed the obliteration of any original structure. For this result even a very few centuries would suffice. It cannot be asserted, therefore, that the sand was not once stratified.

On the other hand, the sand in which the relics are found may have been blown to its present position. The fact that the immediate edge of the bluff is slightly higher than

the plain farther back lends color to this view, but the rise next to the edge of the bluff is very slight, and the conclusion that it is due, at this particular point, to an accumulation of wind-blown material is not necessitated. The explanation of eolian sand in this position would be easy. While the river was cutting its valley in the plain, the bluffs were bare. The bare face of the bluff was made of loose sand and gravel, and the prevailing westerly winds might well have blown sand from the slope to the top of the bluff above. This is just the situation in which dune sand would be expected to accumulate under such circumstances, is indeed just the situation in which it has accumulated at many other points along the Delaware and its tributaries. It is probably not exaggeration to say that dune sand occurs in greater or less quantity along the Jersey side of the river, more than half the way between Trenton and Camden, and throughout the stretch its favorite position is on the edge of the river bluff. The dune sand along the tributaries to the Delaware between Trenton and Camden occurs in the same relations. The very general presence in the region of wind-blown sand on the crests of valley bluffs leads one to suspect the same origin for sands in similar situations, such as that in which the relics are found, even when they cannot be proved to be eolian. The case is still further strengthened by the fact that human relics are very generally found in the sand which is demonstrably eolian.

In the presence of the stones there is an apparent difficulty in the way of ascribing the sands in question to the wind. If, however, the sands were accumulated by the wind after the occupation of the region by early peoples, the larger stones may have been dropped by men upon the surface at the same time with the argillite chips and half-fashioned implements, while the smaller ones might have been blown in. But we

are not shut up to this conclusion. There are various other ways in which pebbles might be introduced into eolian sand. The burrowing animals and the growth and decay of the roots of trees might introduce relics and stones from the top, if they were left by men on the surface. Relics of modern civilization, bits of coal, pieces of brick, etc., were found in the sand down to a maximum depth of seventeen inches. The uprooting of considerable trees might bring up gravel stones of considerable size from depths of several feet into the surface material. If forest trees were ever upturned by winds in this locality they could not fail to bring up pebbles into the sand above the gravel. The breaks in the streaks already referred to might find explanation in such disturbances. In view of these possibilities the presence of the pebbles in the sand cannot be asserted to prove that it is not of wind origin.* Finally, it is believed that no unqualified conclusion concerning the origin of the relic-bearing sand is warranted. It may be of aqueous origin, dating from the close of the last glacial epoch; it may be of aqueous origin of later age, for sea water probably covered the region at the close of the last glacial epoch or later; and it may be eolian, dating from a time long subsequent to the deposition of the sand and gravel of the plain.

Whatever its origin, it may safely be said that the surface material down to the lowest depth at which the relics have been found has been so disarranged that no affirmation can be made concerning the origin of the pebbles and relics it contains. It is all within the zone of active weathering and surface disturbance. If the finds were

fossils, in the usual sense of the term, it is certain that geologists would not feel warranted in attaching much importance to them.

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SANARELLI'S WORK UPON YELLOW FEVER.

At the request of the editor of SCIENCE I append a brief *résumé* of Sanarelli's recent papers upon yellow fever.*

The most important study of yellow fever that appeared before Sanarelli's investigations were undertaken was that made in 1888-9 by Dr. Sternberg, whose researches led to an essentially negative result. Upon only one microorganism found by him in the course of his thoroughgoing investigations did any degree of suspicion fall, and the evidence against this germ was summed up by Sternberg as follows:

"Among the facultative anaërobics is one—my *Bacillus X*—which has been isolated by the culture method in a considerable number of cases and may have been present in all. This bacillus has not been encountered in the comparative experiments made. It is very pathogenic for rabbits when injected into the cavity of the abdomen.

"It is possible that this bacillus is concerned in the etiology of yellow fever, but no satisfactory evidence that this is the case has been obtained by experiments on the lower animals, and it has not been found in such numbers as to warrant the inference that it is the veritable infectious agent.

"All other microorganisms obtained in pure cultures from yellow fever cadavers appear to be excluded, either by having been identified with known species, or by having been found in comparative researches made outside of the area of yellow fever prevalence, or by the fact that they have

* My co-laborer in New Jersey, Mr. George N. Knapp, visited the locality where the relics are found in June, and reached the conclusion that the sands in question are eolian. No one else has more intimate familiarity with these sands than he.

* *Annales de l'Institut Pasteur*, June, September, October, 1897.